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## General

The Indian Ocean, the third largest ocean, is bordered on the W by Africa, on the S by Antarctica, on the N by Asia, and on the E by Australia.

The Mid-Indian Ridge, the most notable bathymetric feature of the ocean, lies near the center. It takes the form of an inverted "Y" and has a depth of 2,743m. The Mid-Indian Ocean Basin, with depths of over 5,000m, lies E of this ridge. The Ninetyeast Ridge extends S from the Bay of Bengal on the E side of the basin.

The **Vema Trench** (9°00'S., 67°30'E.), with depths of over 6,000m, lies on the E side of the Mid-Indian Ridge.

The **Java Trench** (10°20'S., 110°10'E.), with a reported maximum depth of 7,449m, is the deepest part of the Indian Ocean.

## Cautions

### ODAS

The term Ocean Data Acquisition System (ODAS) covers a wide range of devices for collecting weather and oceanographic data. However, the devices of most concern to vessels consist of buoy systems which support instruments. These buoy systems may be expected to become more numerous each year and may be found in most oceans.

The buoy systems vary considerably in size and are either moored or free-floating. As far as possible, positions of the former will always be widely promulgated, and, if considered to be of a permanent enough nature, will be charted. In both types, the instruments may be either in the float or attached at any depth beneath it.

The buoys are colored yellow and marked ODAS with an identification number. The moored buoys usually display a yellow light, showing a group of five flashes every 20 seconds.

ODAS equipment may be encountered in unexpected areas and often in deep water where navigational buoys would not be found. It should be noted that valuable instruments are often suspended beneath these systems or attached to the mooring lines. In some cases, the moorings have been cut loose beneath the buoy by unauthorized persons, with the consequent loss of the most valuable part of the system.

The moored buoys may be up to 7.5m in diameter and 2 to 3m in height. The free-floating buoys are usually much smaller, 2m wide, and do not display a light.

### Locust Reports

Many countries in Africa and Southwest Asia are, from time to time, invaded by swarms of Desert Locust. These locusts are capable of traveling for hundreds of miles and have repeatedly been seen in flight at sea within the Gulf of Aden, the Persian Gulf, and the N part of the Indian Ocean. The adult Desert Locust is about 40mm long with a wingspan of about 120mm. They vary in color from red to yellow according to their state of maturity.

Reports of locusts in all infested countries are exchanged through the Desert Locust Information Service, Food and Agriculture Organization of the United Nations, Rome. To assist in the provision of appropriate warnings to countries threatened by locust invasion, mariners sighting locusts are

requested to report by radio, to TELEX 610181 FAOI Rome, Cable FOODAGRI Rome, or telephone 57971 Rome, Italy through the long range coast station at Portishead.

The report should include the following particulars:

1. Date and time (specifying UT/GMT or zone time) when locust first seen.
2. Latitude and longitude, if possible to nearest minute, where locusts first seen.
3. Time and position at which locusts were last seen.
4. Whether isolated locusts (seen in flight singly), locust groups(s) (flying locusts seen intermittently in numbers), swarm (flying locusts seen continuously in numbers over a period of at least a minute), dense swarm (obscuring part of horizon or other background), or locusts appearing on board or floating dead (isolated, groups, or swarms).
5. Color of locusts.
6. Wind direction and speed.

The cost of these messages will be defrayed by the Desert Locusts Information Service.

### Off-lying Dangers

The **Madagascar Plateau** (33°13'S., 43°48'E.), a submarine ridge, lies about 460 miles S of Madagascar. Walters Shoal, with a least depth of 18m, lies on this ridge.

The **Alphard Banks** (35°02'S., 20°52'E.), a series of coral and rock formations, rise from general depths of about 85m to a least depth of 15.5m. Heavy swells and turbulent seas frequently occur, especially during strong SW winds, in the vicinity of these formations.

**Muirfield Sea Mount** (13°10'S., 96°11'E.), with a least depth of 18m, is reported to lie about 70 miles SSW of the Cocos (Keeling) Islands.

### Piracy

Acts of piracy are reported to occur within the waters of the Indian Ocean lying off the W coast of Sumatera. The International Maritime Bureau (IMB) of the International Chamber of Commerce has established a Piracy Countermeasures Center at Kuala Lumpur. This center operates for the Southeast Asian Region and is able to receive reports from vessels concerning attacks and advise of danger areas. Piracy warnings are broadcast by the center. [For further information, see Malaysia—Cautions.](#)

### Freak Waves

An area in the Indian Ocean lying between the Cape of Good Hope and Durban has long been regarded as dangerous due to large swells and the occurrence, without warning, of abnormally high, freak waves. These freak waves are reported to be preceded by a steep trough, often described as a "hole", into which vessels may plunge. Such vessels are then unable to rise up again before encountering a solid wall of water, 20 to 25m high. These freak waves have usually been reported to occur within 20 miles of the edge of the Continental Shelf.

While the chances of encountering a freak wave are slight, care should be exercised when navigating in the vicinity of the edge of the Continental Shelf.

## Climatology

The Northeast Monsoon occurs from December to April. The SW monsoon occurs from June to October. Tropical cyclones occur mostly during May, June, October, and November in the N part of the ocean and during January and February in the S part.

The N part of the Indian Ocean has a typical monsoon climate, with the onset of the Southwest Monsoon affecting Sri Lanka and the S part of India from late May to early June and steadily moving NW to affect the NW part of India and the SW part of Pakistan by early July. In early September, the Southwest Monsoon starts to retreat towards the SE and by mid to late December, the Southwest Monsoon has usually cleared most of Sri Lanka.

The weather pattern over much of the area is more regular than in most parts of the world, and is usually classified over most of India, as follows:

1. The cool season (December through March)—Dry NE winds, with little clouds, except in the S.
2. The hot season (April and May)—Light, variable winds, with sea breezes along the coasts, and a small chance of a tropical cyclone.
3. The Southwest Monsoon or rainy season (June through September)—Winds normally W to SW, but along the SW coast of India, winds are W to NW.
4. The interim, or transitional, period (October and November)—Light, variable winds, with sea and land breezes. Occasional tropical cyclones may be experienced.

On the W coast of India, the whole period from the cessation of the Southwest Monsoon to its recommencement is often referred to as the "fine weather season." Along much of the coast of Pakistan and the W coast of India, most of the rainfall is associated with the Southwest Monsoon. The rainy season is more prolonged over the S part of India and Sri Lanka; in the extreme S part of the area, the monthly variation in rainfall is small.

Tropical cyclones (force 12) are infrequent, with an average of one or two occurring over the Arabian Sea each year.

Due to their devastating storm tides, tropical cyclones in the vicinity of the head of the Bay of Bengal have long been recognized as extremely dangerous. As far back as 1737, a "wall of water", reported to be 12m high, swept ashore killing over 300,000 people. In November 1970, a "severe cyclone" (classification used in India in lieu of hurricane) sent a 7m storm surge over Bangladesh and the offshore islands with loss of life estimated at about 310,000. This storm generated winds of 130 knots. In the past 35 years, cyclones, at times, have generated winds estimated at 150 to 175 knots and waves of up to about 10m high. However, with the increased use of satellites for detection and tracking, more advanced notice can be given and the intensity of the storm determined.

## Government

### Dependent Island Groups

#### British Indian Ocean Territory (Chagos Archipelago)

The British Indian Ocean Territory, which includes the entire Chagos Archipelago, lies about midway between Indonesia and Africa and is a dependent territory of the United Kingdom.



### British Indian Ocean Territory

It is composed of a group of five atolls. The numerous coral islands and banks forming the atolls are flat and only attain heights of up to 4m.

**Diego Garcia** (7°20'S., 72°27'E.) is the largest and southernmost atoll of the group. It is the site of a joint US/UK military facility. There is no permanent population. A constant listening watch for distress radio traffic is maintained at Diego Garcia. There is no agricultural or industrial activity on the atolls. Fishing with traps, handlines, gillnets, and purse seine nets is carried out in the vicinity of the atolls.

The climate is tropical. It is hot and humid, moderated somewhat by the trade winds.

The Time Zone description is ECHO (-5). Daylight Savings Time is not observed.

Antipollution laws are strictly enforced in the area of the atolls.



Flag of British Indian Ocean Territory

### Reunion (Ile de la Reunion)

Reunion (formerly Ile Bourbon) lies about 360 miles E of Madagascar and is a dependent territory of France (an Overseas Department of France). The island, with an area of 968



### Reunion

square miles, is administered by a Prefect, assisted by an elected General Council and Regional Assembly. The seat of administration is situated in **Saint-Denis** (20°52'S., 55°27'E.).

The terrain is mostly rugged and mountainous, with fertile lowlands near the coasts. The island is composed of volcanic formations. Piton des Neiges, 3,069m high, is the summit. Piton de la Fournaise rises in the SE part of the island and is an active volcano.

The climate is tropical, being moderated by the high elevations. It is usually cool and dry from May to November, and wet and rainy from November to April. However, the Northeast Monsoon sometimes brings heavy rains to the E side of the island from October to April.

French is the official language of the island, but Creole is also widely used. The unit of currency is the French franc. The legal system is based on French civil law.

A firing area, identified as FM-D50, is bounded by lines joining the following positions:

- 21 12.0'S, 54 57.0'E.
- 21 26.0'S, 55 02.5'E.
- 21 31.2'S, 54 47.4'E.
- 21 17.2'S, 54 42.0'E.

The following holidays are observed:

New Year's Day	January 1
Easter Monday	Varies
Labor Day	May 1
Victory Day (1945)	May 8
Ascension Day	Varies

Whit Monday	Varies
National Day	July 14
Assumption Day	August 15
All Saints' Day	November 1
Victory Day (1918)	November 11
Slavery Abolition Day	December 20
Christmas Day	December 25

The chief agricultural products are sugar, tropical fruits and vegetables, vanilla, perfume essences, corn, tobacco, potatoes, and maize.

The main industries include sugar processing, rum distilling, cigarettes, canning, fishing, livestock raising, textiles, leather, handicrafts, and tourism.

The Time Zone description is DELTA (-4). Daylight Savings Time is not observed.

The islands of Ile Tromelin (15°53'S., 54°31'E.), Iles Glorie (11°33'S., 47°18'E.), Ile Juan de Nova (17°03'S., 42°43'E.), Ile Europa (22°20'S., 40°21'E.), and Bassas da India (21°27'S., 55°27'E.) are all administratively attached to Reunion, but have no permanent inhabitants.



Flag of Reunion

### The Crozet Islands (Iles Crozet)

The Crozet Islands are an archipelago consisting of two groups of volcanic islands lying about 50 miles apart. This archipelago is a dependent territory of France (an Overseas Department of France). The islands lie between 45°57'S and 46°30'S, and between 50°10'E and 52°20'E.

Ile aux Cochons, with an area of 26 square miles, is the main island of the W group. Its summit, 775m high, is always covered with snow.

Ile de la Possession, the largest island, lies in the E group. It is mostly formed by a splendid mass of volcanic mountains, the summit of which is 935m high and usually covered with snow.

The seat of administration is situated in Port Alfred, at the head of **Crique du Navire** (46°25'S., 51°52'E.), on Ile de la Possession. It is reported that a permanent scientific station is maintained by the French government at Port Alfred.

The winds are often extremely violent in the vicinity of these islands. The sky is usually overcast and the weather cold and bleak.

The Time Zone description is ECHO (-5). Daylight Savings Time is not observed.

French regulations prohibit all fishing within the 12-mile zone of territorial waters and the 200-mile economic zone surrounding the Crozet Islands.

### Amsterdam Island (Ile Amsterdam)

**Amsterdam Island** (37°51'S., 77°33'E.) is a dependent territory of France (an Overseas Department of France). It has an area of 21 square miles and has been declared a sanctuary for all forms of wild life. Antipollution laws are strictly enforced in the vicinity of this island. The island is of volcanic origin and composed of basaltic lava and ashes. It has a high, rugged cone on which stand several old volcanic craters. Some wild cattle, penguins, and seals, frequent the W side of the island.

The seat of administration is situated at Roche Godon, on the NE part of the island. A permanently-inhabited meteorological and scientific station stands at Roche Godon.

The Time Zone description is ECHO (-5). Daylight Savings Time is not observed.

### Saint-Paul Island (Ile Saint Paul)

**Saint-Paul Island** (38°43'S., 77°33'E.) is a dependent territory of France (an Overseas Department of France). It has an area of 2 square miles and has been declared a sanctuary for all forms of wildlife. Antipollution laws are strictly enforced in the vicinity of this island.

The island is formed by the above-water part of an extinct volcano; a large section is occupied by a submerged crater. It has sulfurous hot springs and is overrun with rabbits and rats.

Strong W winds and overcast skies predominate for most of the year. Significant E winds blow between December and March. Gales are common. When SW winds blow, violent squalls usually sweep down the sides of the crater.

The Time Zone description is ECHO (-5). Daylight Savings Time is not observed.

### The Kerguelen Islands (Iles de Kerguelen)

The Kerguelen Islands are an archipelago consisting of over 300 islands, islets, and rocks. This archipelago is a dependent territory of France (an Overseas Department of France). The islands, islets, and rocks lie between 48°27'S and 49°58'S, and between 68°25'E and 70°35'E.

Mont Grand Ross, 1,849m high, is the summit of Grand Terre, the main island. It is always covered with snow and glaciers descend down the sides. Because of the rugged and boggy nature of the ground, in addition to the severity of the climate and the absence of trees and wood, the interior of the island is little visited. It is reported that reindeer, trout, and sheep have been acclimatized.

The seat of administration is situated in **Port aux Francais** (49°21'S., 70°13'E.), on Grand Terre. It is the only permanent and inhabited settlement in the archipelago and is the site of a meteorological and scientific station.

Squalls, descending from the heights with great speed and a deafening roar, quickly transform the surface of the sea near the island into a froth. Even in summer, scarcely a day passes without winds of force 8 or 9 blowing for a few minutes.

The Time Zone description is ECHO (-5). Daylight Savings Time is not observed.

The NW and W coasts of the archipelago have been declared a national park, in which hunting and fishing are forbidden.



French regulations prohibit all fishing within the 12-mile zone of territorial waters surrounding Iles de Kerguelen. All fishing, with the exception of trawling, is prohibited within the 200-mile economic zone. However, trawling is prohibited within the economic zone during the months of March, April, and May and in the SE quadrant of the economic zone, bounded on the N side by 49°30'S and on the W side by 69°00'E, between 15 September and 15 November.

## Navigational Information

### Electronic Navigation and Communication

#### International Maritime Satellite Organization (INMARSAT)

Around the world satellite communication systems have now become synonymous with reliable and quality transfer of information. The International Maritime Satellite Organization (INMARSAT) is an international consortium comprising over 75 partners who provide maritime safety management and maritime communications services.

The INMARSAT system consists of a number of satellites, which maintain geosynchronous orbits, and provides quality communications coverage between about 77°N and about 77°S, including locations with less than a 5° angle of elevation.

INMARSAT-A, the original system, provides telephone, telex, and fax services. However, this system is being replaced by INMARSAT-B, which, by the use of digital technology, is providing the services with improved quality and higher data transmission rates.

INMARSAT-C provides a store and forward data messaging capability, but no voice communication.

#### Global Maritime Distress and Safety System (GMDSS)

The Global Maritime Distress and Safety System (GMDSS) provides a great advancement in safety over the previous usage of short range and high seas radio transmissions.

The GMDSS has been adopted by the International Convention for the Safety of Life at Sea (SOLAS) 1974. It applies to cargo vessels of 300 grt and over and all vessels carrying more than 12 passengers on international voyages. Unlike previous regulations, the GMDSS requires vessels to carry specified equipment according to the area in which they are operating. Such vessels navigating in polar regions must carry VHF, MF, and HF equipment and a satellite Emergency Position Indicating Radiobeacon (EPIRB).

Information on the GMDSS, provided by the U.S. Coast Guard Navigation Center, is accessible via the Internet, as follows:

**U. S. Coast Guard Navigation Center**

<http://www.navcen.uscg.mil/marcomms/default.htm>

#### Global Positioning System (GPS)

The NAVSTAR Global Positioning System (GPS) is a satellite-based system, operated by the U.S. Air Force, which provides very accurate positioning, time, and velocity information to multiple users. It is an all-weather system with world wide and continuous usage which will replace OMEGA and other such hyperbolic radio navigation systems. The space

component of GPS consists of 24 satellites, of which a minimum of six are observable from any place on earth. GPS receivers convert data from the satellites to produce three-dimensional positions (latitude, longitude, and altitude). They compute information for fixes in terms of the World Geodetic System (1984) reference ellipsoid; hence, a datum shift correction may be required before a position can be plotted on a chart.

GPS provides two services for navigation positioning, but accuracy of a fix also depends upon the capability of user equipment.

Standard Positioning Service (SPS) is the standard level of positioning and timing accuracy. It is available without restrictions to any user on a continuous world-wide basis and provides horizontal accuracy to approximately 100m.

Precise Positioning Service (PPS) is limited to authorized users and provides horizontal accuracy to approximately 30m.

#### SafetyNET

NAVTEX is an international automated direct printing service for the promulgation of navigational and meteorological warnings and urgent information to ships. It is a component of the World Wide Navigational Warning Service (WWNWS) and is an essential element of GMDSS.

The SafetyNET broadcast system provides the same information as NAVTEX to vessels on the high seas beyond NAVTEX coverage (generally about 200 miles offshore) and is delivered by the INMARSAT-C system.

#### General Information

For further information concerning the International Maritime Satellite Organization (INMARSAT), the Global Maritime Distress and Safety System (GMDSS), the SafetyNET system, and the Global Positioning System (GPS), see Pub. No. 9, *The American Practical Navigator* (Bowditch-2002 Edition); Pub. 117, *Radio Navigation Aids*; and *Annual Notice to Mariners* No. 1.

## Routes

Vessels leaving the Indian Ocean by rounding the S end of Africa from the N and E should remain in the strength of the Agulhas Current. This current lies 20 to 30 miles off the coast, but is favorable as close as 6 or 7 miles to the shore. Vessels entering the Indian Ocean from the South Atlantic Ocean should avoid the Agulhas Current by remaining well to the S of it.

The Indonesian and Malaysian governments have requested that tankers larger than 200,000 dwt operating between the Indian Ocean and the North Pacific Ocean not use the Malacca Strait or Singapore Strait. The channels leading through the Malacca Strait and Singapore Strait narrow to widths of about 2 miles and 1.2 miles, respectively. In addition, depths of only about 22m lie in several places in the SE part of the Malacca Strait and in the Singapore Strait. Selat Lombok, leading between the islands of Lombok and Bali, provides the safest route through the Eastern Archipelago for large vessels over 200,000 dwt. The minimum channel width is 11.5 miles and the minimum depth is greater than 140m. Selat Sunda leads between the islands of Sumatera and Jawa. This channel is deep and wide enough for large, deep-draft vessels, but the

currents are strong. In addition, the straits to the N leading to the South China Sea are shallow and dangerous.

## Seas

### Adjacent Waters

Adjacent waters include the Red Sea, the Gulf of Aden, the Arabian Sea, the Gulf of Oman, the Persian Gulf, the Bay of Bengal, the Malacca Strait, Bass Strait, and the Great Australian Bight.

### The Red Sea

Excessive refraction and mirages are frequent in the Red Sea. In November 1902, **Al Ikhwan** (The Brothers Islets) (26°19'N., 34°51'E.) was reported seen from a distance of over 100 miles. The excessive refraction causes an apparent elevation or depression of the horizon and this effect may introduce errors of up to 20' of longitude and 10' of latitude in the results of celestial observations.

Occasionally, the water in the Red Sea suddenly becomes brilliant at night because of bioluminescence. This effect may occur during both winds and calms.

During both monsoons, variable cross currents, which set E or W, occur in all months and are observed in all parts of the Red Sea. The velocity of the majority of these currents does not exceed 1 knot. However, rates exceeding 2 knots have been experienced on extremely rare occasions to the S of 20°N. In addition, currents with rates exceeding 2 knots may occur, at times, in the Strait of Bab al Mandab during the Northeast Monsoon.

Water levels in the Red Sea may fluctuate as a result of changes in winds and atmospheric pressure. Onshore winds or a decrease in atmospheric pressure can cause an increase in the water level, whereas offshore winds or an increase in atmospheric pressure can cause a lowering of the level. The maximum fluctuations in water level may be about 0.7m higher in winter than in summer. This phenomenon is especially noticeable in the vicinity of Jiddah where numerous reefs only uncover during the summer.

Numerous drilling and production platforms, oil wells, and associated structures, many of which are unlighted or lighted only by flares, are situated in the Red Sea and Gulf of Suez.

The S part of the Red Sea is one of the hottest areas on earth; temperatures as high as 47.7°C have been recorded.

### The Gulf of Aden

Excessive refraction phenomena in all forms is common in the Gulf of Aden, but haze is infrequent, except in summer.

The currents in the gulf are seasonal, mainly depending on the monsoons of the N part of the Indian Ocean.

Numerous drilling and production platforms, oil wells, and associated structures, many of which are unlighted or lighted only by flares, are situated in the gulf.

Sand storms, known locally as "khamsin" may occur in the gulf without warning and frequently set in with great violence from the N.

### The Arabian Sea

Care should be exercised during the Southwest Monsoon in the Arabian Sea when the weather may be stormy, the sea heavy, and the land often obscured by thick haze.

Great caution is advisable off Ras Aser (Capo Guardafui) and in the region of Suqutra (Socotra) due to the likelihood of some degree of onshore set at any time of the year. The East African current branches E into the ocean to the S of Suqutra and is very strong during the SW monsoon, especially from July to September. During these months, the area with strongest currents lies between 7°30'N and 10°30'N, and between 51°30'E and 54°30'E. Many of the currents have rates of 4 to 5 knots and occasionally some currents attain rates of 6 to 7 knots. Between Suqutra and 14°N, the currents usually attain maximum rates of 2 to 3 knots during the SW monsoon.

The most probable direction of movement of tropical storms off the SE coast of Arabia is towards the NW. However, individual storms are liable to move erratically on almost any course. Although tropical storms (cyclones) are rarely encountered in these waters, they are very dangerous due to the difficulty of forecasting their approach. Therefore, any unusually signs of bad weather should always be noted, especially at the change of the monsoons when cyclones are most likely to be experienced.

Small scale whirlwinds, which may give rise to dust-devils over land or waterspouts at sea, may occur in the region of the Arabian Sea.

Luminosity of the sea occurs in this region and a "white water" phenomena is quite common within the Arabian Sea. With a strong monsoon blowing and a high sea, the horizon has been reported to become suddenly very clear. In addition, a white bank that seemed to be rushing toward the ship has appeared dead ahead. A short time later, the sea was reported to be a sheet of pure white that lit up the surroundings to the brilliancy of a full moon. After an hour, this phenomena gradually faded away. Other reports described the surface of the sea being smooth with flashes of light giving it a violent, agitated appearance like breakers on a low beach.

### The Gulf of Oman

Haze is frequent in this region and strong tidal currents occur in the extreme N part of the gulf.

Fish aggregation devices are reported to lie close off the coast in this area.

### The Persian Gulf

Numerous drilling and production platforms, seismic survey vessels, oil wells, pipelines, and associated structures are situated in the gulf. It should be noted that flares for burning off gas emanating from oil rigs are sometimes very bright and difficulty may be experienced in sighting navigational lights in their vicinity. Movements of mobile drilling rigs and vessels engaged in seismic surveys are promulgated by local notices to mariners issued by the Middle East Navigation Aids Services (MENAS). Notices are not issued for movements within existing fields or in areas of no navigational significance. In certain circumstances, MENAS will also broadcast their movements through local coast radio stations. The Iranian authorities also issue local notices. Movements of mobile rigs and survey vessels are also promulgated through NAVAREA IX radio navigation warnings.

Vessels are cautioned that many submarine pipelines within the gulf are not buried and may rise up to 2m above the bottom.

It was reported (1991) that several oil production platforms in the gulf have been removed. However, all that remains in

many such cases are pipes standing 3 to 6m above the waterline. These pipes are a hazard to navigation and are not radar conspicuous.

Sandwaves are known to exist in many parts of the Persian Gulf and caution is advised. Although the range of the tide in the gulf nowhere exceeds 3m and is less than 2m in the S part, such heights may be crucial to the under-keel clearance of deep-draft vessels that are required to predict the rise of tide for locations in the open sea at considerable distances from the reference stations in the tables. Because of the complex nature of the tides and the existence of amphidromic points in the gulf, predictions based on the nearest port may be considerably in error. In extreme cases, the HW at a port may coincide with the LW at a location in the open sea no more than 50 miles distant.

At some ports within the gulf, regulations stipulate the minimum underkeel clearance permissible for ships entering or leaving. It must be appreciated that such clearances are calculated allowing for ships following accurately surveyed channels in relatively sheltered waters with no heavy seas or swells and proceeding at low speeds. Under no circumstances should such regulations be taken as a guide to safe underkeel clearance in the open sea.

Strong winds blowing from a constant direction for a prolonged period may set up surface currents in the gulf, which can lower the sea level in some places and raise it in others.

Haze, especially in summer and also during winter in the S part of the gulf, often completely obscures the land and reduces the visibility of shore lights. In addition, sand storms have been reported to suddenly reduce visibility to less than 1,000m.

Strong tidal currents setting near the entrance of the Persian Gulf necessitate caution. Off **Ras Musandam** (26°23'N., 56°32'E.), on the W side of the entrance, the current has been reported to attain rates of over 4 knots. Within the gulf, the set caused by the winds is sometimes so great that an opposing tidal current fails to overcome it. The resulting set continues in the same direction as before and merely changes its rate.

Except at the entrance, the Arabian coast of the gulf is low and, in places, shoals and reefs lie up to 50 miles offshore. Traffic Separation Schemes (TSS) and buoyed channels are provided for safe navigation in this area.

In addition to dust storms and haze, squalls with waterspouts are also common in the gulf, particularly in autumn. Wind gusts of up to 95 knots winds have been recorded during these squalls.

Temperatures are very high in the open gulf and may reach 45°C.

An unusual oceanographic phenomenon of the open gulf is the submarine spring formed off Bahrain. The source of this artesian fresh water upwelling is reported to be the Jabal Tuwayq in Arabia.

Part of the trade between the Persian Gulf, India, the Red Sea, and the E coast of Africa, is carried on by local vessels. Such small vessels are known as "bagala" or "bum boats" by

the Arabs. Similar Indian-built vessels are called "kutiyah" or "dangiyah." The term "dhow" (from the Swahili word "daw") is mostly unknown to the inhabitants of the Persian Gulf littoral, but is used commonly by Europeans to denote any local sailing craft.

Local magnetic disturbances have been reported to occur within the gulf.

Vessels are advised that mined areas exist in the N part of the gulf. Swept routes are provided in the approaches to ports and information concerning them should be obtained from the local authorities. Mine sightings should be reported to the naval authorities by IMARSAT (150 5612) or by VHF. Further details of areas reported to be dangerous due to mines are promulgated by Navigation Notices issued by the Middle East Navigation Aids Service (MENAS). In addition, see Annual U.S. Notice to Mariners No. 1 (MARAD Advisories).

### The Bay of Bengal

The Bay of Bengal lies in the NE part of the Indian Ocean and is dominated by the monsoon winds. During spring, the current in the bay has a strong clockwise circulation. In autumn, the current is weaker and counterclockwise. The heaviest rains occur during autumn and the surface water tends to pile up on the W side of the bay. This, combined with the funnel shape of the bay and shoaling of its bottom, causes high tides and seiches.

The vast delta of the Ganges River lies at the head of the bay and has many mouths. The Hooghly, the W branch of the Ganges, forms the main route for oceangoing ships bound for Calcutta. The Meghna, lying 180 miles E of the Hooghly, discharges the main volume of water from the Ganges. At times, tidal bores occur during spring tides in these branches.

### The Malacca Strait

The Malacca Strait, which forms the main route connecting the Indian Ocean with the South China Sea, is about 500 miles long. The channel fairway narrows to a width of about 8 miles at the E end where it joins the Singapore Strait.

Large sandwaves are reported to be formed, with crests at right angles to the direction of the tidal currents, on the bottom of the strait. These sandwaves form where strong tidal currents occur and rise 4 to 7m above the bottom. In addition, long sand ridges, running parallel to the direction of the tidal currents, are also formed. Therefore, deep-draft vessels should take particular note of the latest reports concerning depths in or near the fairway.

Navigational aids are difficult to maintain within the strait and are reported to be frequently unreliable.

Heavy traffic is often encountered within the strait and maneuvering room may be restricted, at times, by numerous fishing craft.

[For information concerning Navigation Rules for the Malacca and Singapore Straits, see Singapore—Regulations.](#)